A Grid Connected Dual Voltage Source Inverter with Improvement Power Quality Features

R.Chander [1], Dasari Raghu[2]

Research Scholar Department of Electrical Engineering University College of Engineering (A)Osmania University, Hyderabad ,Telangana, India

M.Tech student, PE Chaitanya Institute Of Engineering & Technology,Warangal, Telangana ,India

***Abstract*- This paper provides a dual voltage supply inverter (DVSI) program to improve the power quality in addition to reliability of the microgrid system. The proposed scheme is actually composed of 2 inverters, which makes it possible for the microgrid to exchange power produced by the distributed energy resources (DERs) and to compensate the nearby unbalanced as well as nonlinear load. The control algorithms are actually developed predicated on instantaneous symmetrical component theory (ISCT) to use DVSI in grid posting and grid injecting ways. The proposed plan has greater dependability, lower bandwidth dependence on the crucial inverter, less costly because of to reduce infiltration size, and much better use of micro grid ability when working with reduced dc link voltage score for the crucial inverter. The DVSI is actually made by the characteristics design a promising alternative for micro grid offering hypersensitive lots. The control and topology algorithm are actually validated through experimental results and comprehensive simulation.**

***Index Terms*- DVSI, Instantaneous Symmetrical Aspect Theory (ISCT), DERs.**

I. INTRODUCTION

To drive the power system there are many models or pattern with more renewable energy sources interlinked with the network by using distributed generation (DG). These DG units can control of local generation, storage facilities from a micro-grid. A micro-grid, power can be taken from the different renewable energy sources such as fuel cells, photovoltaic systems, and wind energy systems are merged to grid and loads using (PEC) power electronic converters. To exchange the power from micro-grid to grid and connected load by using an interactive grid inverter. This micro-grid inverter can either work in a grid sharing mode or in grid injecting mode, the grid sharing is done while supplying a part of local load, the grid injecting is done by injecting power to the main grid. Another important aspect is maintaining power quality it has to be done when the microgrid is connected to the main grid. The number of feeder impedance in the distribution systems, the propagation of these harmonic currents distorts the voltage at the point of common coupling (PCC). The microgrid generating power from main voltage source inverter (MVSI) as real power and the compensation of reactive, harmonic, and unbalanced load compensation which performed by (AVSI) auxiliary voltage source inverter. An important advantage of MVSI that it can always be used to inject real power to the grid with rated capacity and it also as sufficient renewable power is available at the dc link. The two inverters is supplies total power to the load and also reduces the switching losses across the semiconductor switches. By this reduction of losses will increase the system reliability when it compares to single inverter. In this scheme a smaller size modular inverters are used. Because these inverters can operate at high switching frequencies with a reduced size of interfacing inductor, so that the filter cost gets reduced.

The main inverter which supplies the real power to track the fundamental positive sequence of current and also the inverter reduces the bandwidth requirement of the main inverter. The inverters in the present scenario use two separate dc links. Since the auxiliary inverter is supplying zero sequence of load current. In MVSI the single dc storage capacitor with three-phase three-leg inverter structure can be used. It reduces the dc-link voltage requirement of the main inverter. Thus, the use of AVSI and DVSI inverters in the system structure which provides the system reliability, micro-grid power is utilized better and also reduces the voltage rating of the grid.

Control algorithms is developed (ISCT) to operate DVSI in grid connected mode when considering non stiff grid voltage. The dq0 transformation method is used to extract the fundamental positive sequence of PCC voltage q0 transformation. The control strategies are measured with the parallel inverters connected to a three phase four-wire distribution system.

II. PROPOSED STRATEGY

Electric power quality (EPQ), or simply Power quality, refers to "maintaining the near sinusoidal waveform of power distribution bus voltages and currents at rated magnitude and frequency.",[1] determining the fitness of electric power to consumer devices. Synchronization of the voltage frequency and phase allows electrical systems to function in their intended manner without significant loss of performance or life. The term is used to describe electric power that drives an electrical load and the load's ability to function properly. Without the proper power, an electrical device (or load) may malfunction, fail prematurely or not operate at all. There are many ways in which electric power can be of poor quality and many more causes of such poor quality power. The electric power industry comprises electricity generation (AC power), electric power transmission and ultimately electric power distribution to an electricity meter located at the premises of the end user of the electric power.

The electricity then moves through the wiring system of the end user until it reaches the load. The complexity of the system to move electric energy from the point of production to the point of consumption combined with variations in weather, generation, demand and other factors provide many opportunities for the quality of supply to be compromised. While "power quality" is a convenient term for many, it is the quality of the voltage rather than power or electric current that is actually described by the term. Power is simply the flow of energy and the current demanded by a load is largely uncontrollable.

The proposed DVSI topology is shown in Fig. 1. It consists of a neutral point clamped (NPC) inverter to realize AVSI and a three-leg inverter for MVSI. These are connected to grid at the PCC and supplying a nonlinear and unbalanced load. The function of the AVSI is to compensate the reactive, harmonics, and unbalance components in load currents. Here, load currents in three phases are represented by ila, ilb, and ilc, respectively. Also, ig(abc), iμgm(abc), and iμgx(abc) show grid currents, MVSI currents, and AVSI currents in three phases, respectively. The dc link of the AVSI utilizes a split capacitor topology, with two capacitors C1 and C2. The MVSI delivers the available power at distributed energy resource (DER) to grid. The DER can be a dc source or an ac source with rectifier coupled to dc link. Usually, renewable energy sources like fuel cell and PV generate power at variable low dc voltage, while the variable speed wind turbines generate power at variable ac voltage. Therefore, the power generated from these sources use a power conditioning stage before it is connected to the input of MVSI.

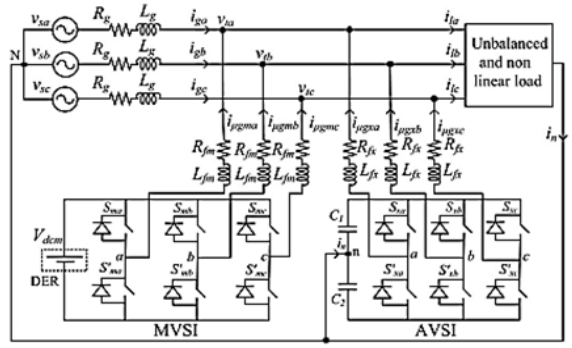

Fig. 1. *Topology of proposed DVSI scheme*

In this study, DER is being represented as a dc source. An inductor filter is used to eliminate the high-frequency switching components generated due to the switching of power electronic switches in the inverters. The system considered in this study is assumed to have some amount of feeder resistance R_g and inductance L_g. Due to the presence of this feeder impedance, PCC voltage is affected with harmonics.

A. Design of DVSI Parameters

AVSI: The vital parameters of AVSI like dc link voltage (Vdc), dc storage capacitors (C2 and C1), interfacing inductance (Lfx), as well as hysteresis band (±hx) are actually selected based on the layout technique of split capacitor DSTATCOM topology. The dc link voltage across each capacitor is actually taken as 1.6 times the good of phase voltage. The total dc link voltage reference (Vdcref) is actually discovered to remain 1040 V. Values of dc capacitors of AVSI are picked based on the shift in dc link voltage during transients. Let total load rating is actually S kVA. In the most severe situation, the load power might differ from minimum to maximum, i.e., from zero to S kVA. AVSI requires to exchange power that is real during transient to keep the ton power demand. This transfer of power that is real during the transient will outcome in deviation of capacitor voltage from its reference worth. Believe that the voltage controller requires n cycles, i.e., nT seconds to act, in which T is actually the process time period. Hence, highest power exchange by AVSI during transient is going to be nST. This energy is going to be identical to shift in the capacitor saved energy. Therefore

$$\frac{1}{2}C_1(V_{dcr}^2 - V_{dc1}^2) = nST \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where Vdcr and Vdc1 are the reference dc voltage and maximum permissible dc voltage across C1 during transient, respectively. Here, S =5 kVA, Vdcr = 520 V, Vdc1 = 0.8 Vdcr or 1.2 Vdcr, n = 1, and T = 0.02 s. Substituting these values in (1), the dclink capacitance (C1) is calculated to be 2000 μF. Same value of capacitance is selected for C2. The interfacing inductance is given by

$$L_{fx} = \frac{1.6V_m}{4h_x f_{max}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Assuming a maximum switching frequency (fmax) of 10 kHz and hysteresis band (hx) as 5%of load current (0.5 A), the value of Lfx is calculated to be 26 mH. 2) MVSI: The MVSI uses a three-leg inverter topology. Its dc-link voltage is obtained as 1.15 Vml, where Vml is the peak value of line voltage. This is calculated to be 648 V. Also,MVSI supplies a balanced sinusoidal current at unity power factor. So, zero sequence switching harmonics will be absent in the output current of MVSI. This reduces the filter requirement for MVSI as compared to AVSI. In this analysis, a filter inductance (Lfm) of 5 mH is used.

B. GRID-TIE Inverter:

A grid-tie inverter is a power inverter that converts direct current (DC) electricity into alternating current (AC) with an ability to synchronize to interface with a utility line. Its applications are converting DC sources such as solar panels or small wind turbines into AC for tying with the grid. Residences and businesses that have a grid-tied electrical system are permitted in many countries to sell their energy to the utility grid. Electricity delivered to the grid can be compensated in several ways. "Net metering" is where the entity that owns the renewable energy power source receives compensation from the utility for its net outflow of power.

A multifunctional power electronic converter for the DG power system is described in. This scheme has the capability to inject power generated by WES and also to perform as a harmonic compensator. Most of the reported literature in this area discuss the topologies and control algorithms to provide load compensation capability in the same inverter in addition to their active power injection. When a grid-connected inverter is used for active power injection as well as for load compensation, the inverter capacity that can be utilized for achieving the second objective is decided by the available instantaneous micro grid real power. Considering the case of a grid-connected PV inverter, the available capacity of the inverter to supply the reactive power becomes less during the maximum solar isolation periods. At the same instant, the reactive power to regulate the PCC voltage is very much needed during this period. It indicates that providing multi functionalities in a single inverter degrades either the real power injection or the load compensation capabilities. This paper demonstrates a dual voltage source inverter (DVSI) scheme, in which the power generated by the micro grid is injected as real power by the main voltage source inverter (MVSI) and the reactive, harmonic, and unbalanced load compensation is performed by auxiliary voltage source inverter (AVSI).

This has an advantage that the rated capacity of MVSI can always be used to inject real power to the grid, if sufficient renewable power is available at the dc link. In the DVSI scheme, as total load power is supplied by two inverters, power losses across the semiconductor switches of each inverter are reduced. This increases its reliability as compared to a single inverter with multifunctional capabilities. Also, smaller size modular inverters can operate at high switching frequencies with a reduced size of interfacing inductor, the filter cost gets reduced. Moreover, as the main inverter is supplying real power, the inverter has to track the fundamental positive sequence of current. This reduces the bandwidth requirement of the main inverter. The inverters in the proposed scheme use two separate dc links. Since the auxiliary inverter is supplying zero sequence of load current, a three-phase three-leg inverter topology with a single dc storage capacitor can be used for the main inverter. This in turn reduces the dc-link voltage requirement of the main inverter. Thus, the use of two separate inverters in the proposed DVSI scheme provides increased reliability, better utilization of micro grid power, reduced dc grid voltage rating, less bandwidth requirement of the main inverter, and reduced filter size. Control algorithms are developed by instantaneous symmetrical component theory (ISCT) to operate DVSI in grid-connected mode, while considering non stiff grid voltage. The extraction of fundamental positive sequence of PCC voltage is done by dq0 transformation. The control strategy is tested with two parallel inverters connected to a three-phase four-wire distribution system. Effectiveness of the proposed control algorithm is validated through detailed simulation and experimental results.

III.SIMULATION AND RESULTS

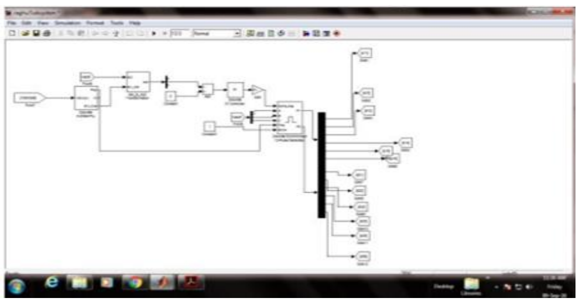

Fig. 2 *Simulation diagram showing the control strategy of proposed D VSI scheme*

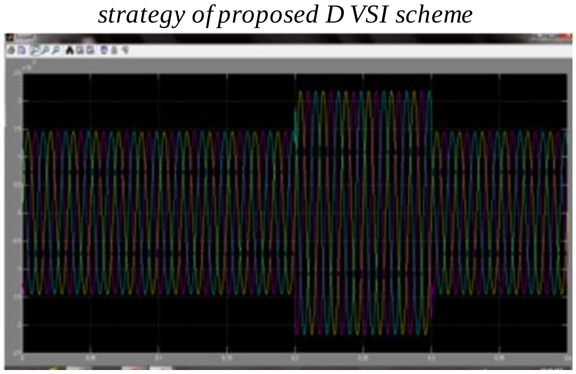

Fig.3*Voltage swell during non linear load parallel to the dual inverter connected load*

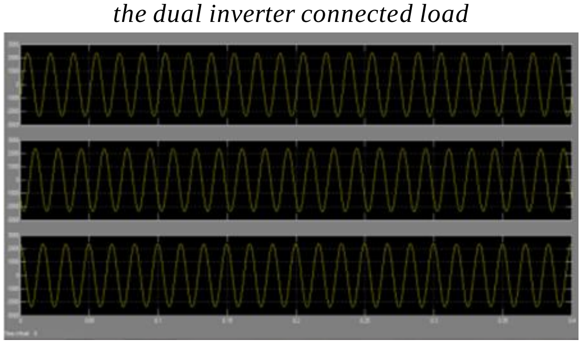

Fig. 4 *voltages of dual inverter fed line of 3-phase*

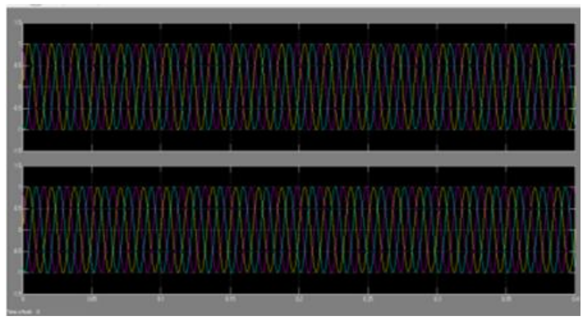

Fig. 5 *Voltages and currents of 3-phase load*

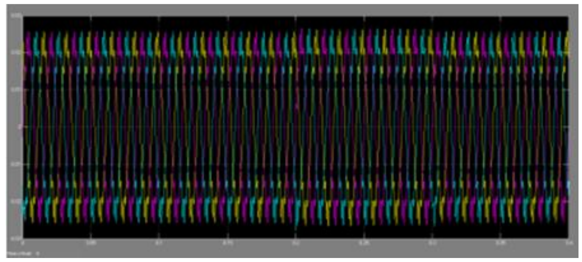

Fig .6 *dual fed line of 3-phase currents*

IV. CONCLUSION

A DVSI scheme is proposed for microgrid systems with enhanced power quality. Control algorithms are developed to generate reference currents for DVSI using ISCT. The proposed scheme has the capability to exchange power from distributed generators (DGs) and also to compensate the local unbalanced and nonlinear load. The performance of the proposed scheme has been validated through simulation and experimental studies. As compared to a single inverter with multifunctional capabilities, a DVSI has many advantages such as, increased reliability, lower cost due to the reduction in filter size, and more utilization of inverter capacity to inject real power from DGs to microgrid. Moreover, the use of three-phase, three wire topology for the main inverter reduces the dc-link voltage requirement.

REFERENCES

[1] A.Kahrobaeian and Y.-R.Mohamed,―Interactive distributed generation interface for flexible micro-grid operation in smart distribution systems, IEEE Trans. Sustain. Energy, vol. 3, no. 2, pp. 295–305, Apr. 2012.

[2] N. R. Tummuru, M. K. Mishra, and S. Srinivas, ―Multifunctional VSC controlled microgrid using instantaneous symmetrical components theory, IEEE Trans. Sustain. Energy, vol. 5, no. 1, pp. 313–322, Jan. 2014.

[3] Y. Zhang, N. Gatsis, and G. Giannakis, ―Robust energy management for microgrids

with high-penetration renewables, IEEE Trans. Sustain. Energy, vol. 4, no. 4, pp. 944–953, Oct. 2013.

[4] R. Majumder, A. Ghosh, G. Ledwich, and F. Zare, Load sharing and power quality enhanced operation of a distributed microgrid, IET Renewable Power Gener., vol. 3, no. 2, pp. 109–119, Jun. 2009.

[5] J. Guerrero, P. C. Loh, T.-L. Lee, and M. Chandorkar, Advanced control architectures for intelligent microgrids Part II: Power quality, energy storage, and ac/dc microgrids, IEEE Trans. Ind. Electron., vol. 60, no. 4, pp. 1263–1270, Dec. 2013.

[6] Y. Li, D. Vilathgamuwa, and P. C. Loh, Microgrid power quality enhancement using a three-phase four-wire gridinterfacing compensator, IEEE Trans. Ind. Appl., vol. 41, no. 6, pp. 1707–1719, Nov. 2005.

[7] M. Schonardie, R. Coelho, R. Schweitzer, and D. Martins, Control of the active and reactive power using dq0 transformation in a three-phase grid-connected PV system, in Proc. IEEE Int. Symp. Ind. Electron., May 2012, pp. 264–269.

[8] R. S. Bajpai and R. Gupta, ―Voltage and power flow control of grid connected wind generation system using DSTATCOM, in Proc. IEEE Power Energy Soc. Gen. Meeting—Convers. Del. Elect. Energy 21st Century, Jul. 2008, pp. 1–6.

[9] S. Boobalan, R. Dhananesekaran, "Improving Power quality of Renewable energy source by using UPQC bassed on multilevel topology, International science press I J C T A, 8(4), 2015, pp. 1433-1443.

[10] P. Kalyana sundaram, R. Neela. "Automation classification of power quality disturbances using MLP network", International science press I J C T A, 8(4), 2015, pp. 1337-1350.